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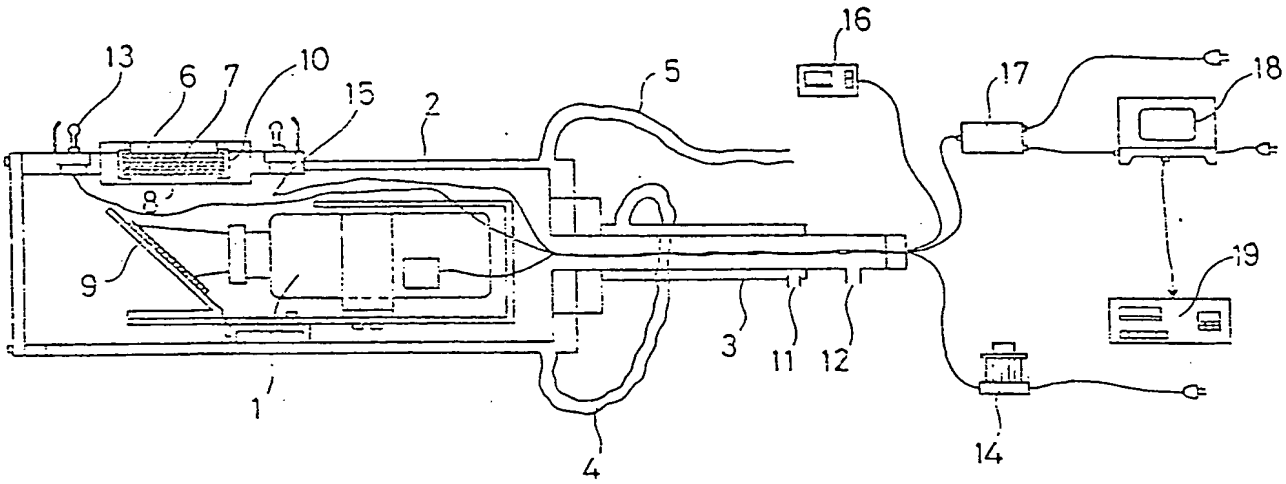
(54) INSPECTION APPARATUS FOR HOT FURNACE.

(57) This invention relates to an apparatus for inspecting the inside of a hot furnace. In an apparatus for inspecting the inside of a hot furnace provided with a camera (1) placed in a case (2) whose inner periphery is cooled by cooling water and to the inside of which cooling air is blown, the present invention disposes sequentially quartz glass (6), heat-ray reflecting glass (7), heat-ray absorption glass (8) and a heat-ray transmitting mirror (9) in the optical path of the rays of light coming from the front surface of the case (2) to the camera (1) and disposes also an illumination lamp (13) on the front surface of the case (2) so as to make remote-control of brightness. In this manner, the inside of the camera case (2) is kept below 50 °C, damage to the camera (1) by the heat of radiation from the glass surface is prevented and remote control of brightness of the illumination lamp (13) is made so that the inspection inside the hot furnace can be made at a temperature ranging from normal temperature to 1,200 °C.

EP 0 364 578 A1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APPARATUS FOR OBSERVING THE INTERIOR OF A HOT FURNACE

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

This invention relates to an apparatus for observing the refractories of a furnace or the like, such as a coke oven, blast furnace, metal mixer, melting pot, converter, or vacuum degasifier, with a view to examining them for wear or damage.

DESCRIPTION OF THE RELATED ART

Generally, the refractory lining of a furnace or the like, such as a coke furnace, blast furnace, metal mixer, melting pot, converter, or vacuum degasifier, is gradually worn away during operation. Hence the necessity for the refractories to be observed to monitor the wear or damage before they become so thin that they can no longer stand operation.

Conventionally, the degree of wear or damage the refractories of a hot furnace have been determined with an apparatus having a camera of a double-water-cooling structure in which cooling air is blown into the camera chamber.

However, in the conventional observing apparatus, equipped with a camera having a double-water-cooling structure in which cooling air is simply blown into the

camera chamber, the interior of the camera can suffer damage due to the radiation entering the apparatus and heating it through the glass window thereof when used in a space at a high temperature of 900°C or more. In addition, the automatic diaphragm of commercial cameras only provides a narrow permissible temperature range of 900 to 1200°C, so that observation cannot be performed to a satisfactory degree.

SUMMARY OF THE INVENTION

This invention has been made with a view to eliminating the above problems experienced with conventional apparatuses. It is accordingly the object of this invention to provide an apparatus for observing the interior of a hot furnace which employs a commercial TV camera capable of remote control of zooming and focusing and in which damage to the camera due to the radiation heat entering through the glass window is avoided, thereby making it possible to conduct observation in a temperature range of from room temperature to 1200°C.

To achieve this object, this invention provides an apparatus for observing the interior of a hot furnace. The apparatus is equipped with a camera arranged in a case whose inner surface is cooled by means of cooling water and into whose inner space cooling air is blown, the apparatus comprising: a quartz-glass plate, a heat-ray-reflecting-

glass plate, a heat-ray-absorbing-glass plate, and a heat-ray-transmitting mirror arranged in order of decreasing distance to the camera in an optical path through which a ray of light entering at the front surface of the case is led to the camera; and an illuminating lamp which is provided on the front surface of the case and whose luminance can be remote-controlled.

As stated above, the hot-furnace-interior observing apparatus of this invention, which is equipped with a camera arranged in a case whose inner periphery is cooled by means of cooling water and into whose inner space cooling air is blown, comprises: a quartz-glass plate, a heat-ray-reflecting-glass plate, a heat-ray-absorbing-glass plate, and a heat-ray-transmitting mirror that are arranged in order of decreasing distance to the camera in the optical path through which the ray of light entering at the front surface of the case is led to the camera; and an illuminating lamp which is arranged on the front surface of the case and whose luminance can be remote-controlled. With this construction, the temperature in the case can be kept at 50°C or less, damage to the camera due to the radiation heat entering through the glass window can be avoided, and the interior of a hot furnace can be observed over a temperature range of room temperature to 1200°C while remote-controlling the luminance of the illuminating lamp.

BRIEF DESCRIPTION OF THE DRAWINGS

The attached drawing is a diagram showing an embodiment of a hot-furnace-interior observing apparatus in accordance with this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of this invention will now be described with reference to the attached drawing.

The embodiment of the hot-furnace-interior observing apparatus shown includes a video camera 1, a video-camera case 2, a camera-case supporting pipe 3, a water hose 4, a water discharge hose 5, a quartz-glass plate 6, a heat-ray-reflecting-glass plate 7, a heat-ray-absorbing-glass plate 8, a heat-ray-transmitting mirror 9, a cooling-air passing slit 10, a cooling-water inlet 11, a compressed-air inlet 12, an illuminating lamp 13, a luminance adjusting transformer 14, a temperature sensor 15, a temperature indicator 16, a remote-control box 17, a monitor-television set 18, and a recorder 19.

In the apparatus shown, cooling water enters at the cooling-water inlet 11 and cools the supporting pipe 3. It then passes through the water hose 4 and flows into the video-camera case 2, thereby cooling the case. The water is then discharged to the exterior through the water discharge hose 5.

Cooling air enters the apparatus at the compressed-air

inlet 12 and cools the interior of the camera case 2 before being discharged to the exterior through the slit 10 provided around the glass system composed of the quartz-glass plate, the heat-ray-reflecting-glass plate, and the heat-ray-absorbing-glass plate. These glass plates are arranged in order from the exterior thus: the quartz-glass plate 6, the heat-ray-reflecting-glass plate 7, and the heat-ray-absorbing-glass plate 8. Provided between adjacent glass plates are clearances of about 2mm, through which the cooling air is allowed to flow, thereby effectively cooling the glass plates.

A ray of light entering the apparatus first passes through the quartz-glass plate 6, and up to about 98% of the long-wave light-ray component having a wavelength ranging from 800nm (nm = 1/1000μm) to 900nm is reflected by the heat-ray-reflecting-glass plate 7. Of the portion of the ray of light which is allowed to reach the heat-ray-absorbing-glass plate 8, about 97% of the components thereof having a wavelength of 90nm or more are either reflected or absorbed. As for the portion of light rays which is allowed to pass through the heat-ray-absorbing-glass plate 8, those components having a long wavelength are transmitted through the heat-ray-transmitting mirror 9, thus allowing only the visible rays to be reflected by the mirror to reach the video camera 1. The image thus observed is displayed on the

monitor-television set 18 and is recorded by the recorder 19 as needed. The zooming and focusing of the video camera 1 can be remote-controlled at will by manipulating a remote-control operation box 17.

The temperature in the case is measured by the sensor 15 and is constantly monitored through the temperature indicator 16. In addition to the cooling effect of the above-mentioned cooling water and air, the intrusion of heat radiation through the window is prevented to the utmost, thereby making it possible to keep the temperature in the case at 50°C or less, thus avoiding damage to the camera.

The built-in camera has an automatic-diaphragm function, the allowable temperature range of which is 900°C to 1200°C. In view of this, the illuminating lamp 13 is provided, and its luminance is adjusted by remote-controlling the voltage supply, thereby making it possible to extend the lower-temperature side of the allowable temperature range down to room temperature.

Thus, this invention makes it possible to keep the temperature in the camera case at 50°C or less, to avoid damage to the camera due to the radiation heat entering through the glass window, and to heighten the withstand temperature of the camera from the conventional 900°C to 1200°C. Furthermore, by remote controlling the luminance of the illuminating lamp, the interior of a hot furnace can be

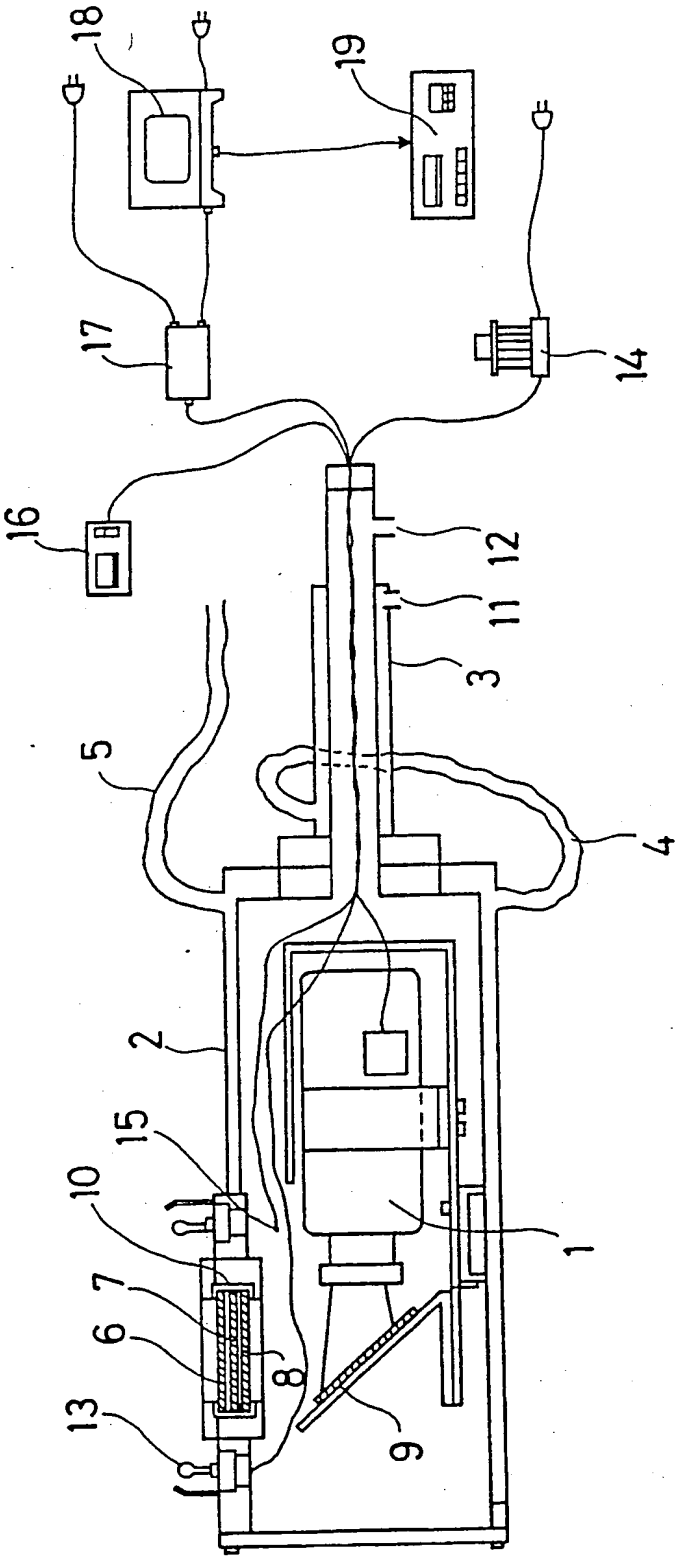
observed over a temperature range of room temperature to 1200°C.

As described above, the apparatus of this invention employs a commercial camera the zooming and focusing of which can be remote-controlled. This apparatus is free from damage to the camera due to the radiation heat entering through the glass window and is suited for observing the interior of a hot furnace over a temperature range of room temperature to 1200°C

WHAT IS CLAIMED IS:

1. An apparatus for observing the interior of a hot furnace that is equipped with a camera arranged in a case whose inner surface is cooled by means of cooling water and into whose inner space cooling air is blown, said apparatus comprising: a quartz-glass plate, a heat-ray-reflecting-glass plate, a heat-ray-absorbing-glass plate, and a heat-ray-transmitting mirror arranged in the order of decreasing distance to said camera in an optical path through which a ray of light entering at the front surface of said case is led to said camera; and an illuminating lamp which is provided on the front surface of said case and whose luminance can be remote-controlled.

2. An apparatus as claimed in Claim 1, wherein said quartz-glass plate, said heat-radiation-reflecting-glass plate, and said heat-radiation-absorbing-glass plate are arranged with small clearances between them, and wherein a cooling-air passing slit is provided around said glass plates, cooling air being allowed to flow through said clearances and to be discharged through said slit.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INTERNATIONAL SEARCH REPORT

International Application No PCT/JP88/00345

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl[4] F27D21/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	F27D21/02, G01N21/84, 21/88 F23M11/04, G02B23/24

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1926 - 1988
Kokai Jitsuyo Shinan Koho	1971 - 1988

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	JP, A, 61-114085 (Shinagawa Refractories Co., Ltd.) 31 May, 1986 (31.05.86) Page 1, lower left column, lines 4 to 11, page 2, lower right column, lines 14 to 19, Figs. 1 to 3 (Family: none)	1, 2
Y	JP, U, 54-35463 (Hitachi Denshi System Service Kabushiki Kaisha) 8 March, 1979 (08.03.79) (Family: none)	1
Y	JP, U, 59-80445 (Nippon Steel Corporation) 31 May, 1984 (31.05.84) (Family: none)	1
E	JP, A, 63-122933 (Shinagawa Refractories Co., Ltd.) 26 May, 1988 (26.05.88) Page 1, lower left column, lines 4 to 18, Fig. 1 (Family: none)	1, 2

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
June 29, 1988 (29.06.88)	July 18, 1988 (18.07.88)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	